

The Gardens' Bulletin STRAITS SETTLEMENTS

Vol. 2

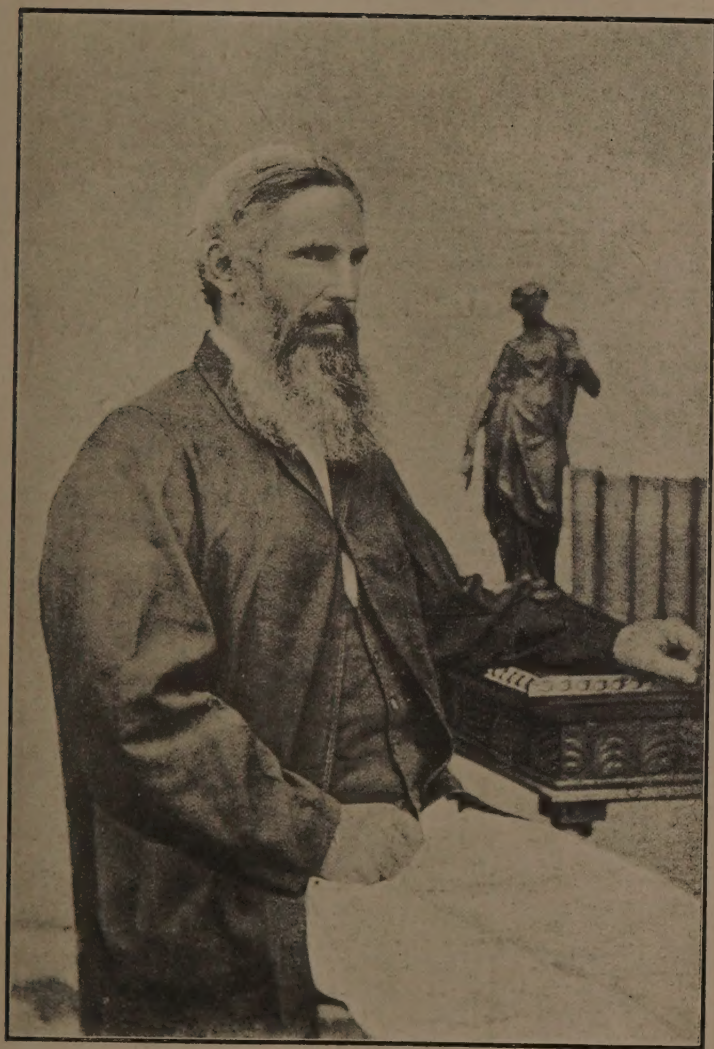
Issued January 31st, 1920.

No. 6

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LAWRENCE NIVEN
Superintendent of the Botanic Gardens
Singapore, 1860-1875.

THE
GARDENS' BULLETIN,
STRAITS SETTLEMENTS.

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Mr. Lawrence Niven.

Mr. Lawrence Niven commenced work at the Botanical Gardens almost as soon as they were opened by the "Singapore Agri-horticultural Society," which was formed in 1859. The Gardens were developed in 1861-62 and after successful shows in the former year, it is recorded that "The Society had obtained the part time services of Mr. Lawrence Niven as Superintendent." Mr. Niven was also superintendent of an adjoining nutmeg plantation, so that he could combine the two very well. He earned the thanks of the Committee for "his taste in laying out the Gardens," and Mr. Buckley records that he made the Gardens very attractive by large beds of pretty flowers. He is also mentioned with praise in the Gardens Guide published in 1889. The title of his office, which was more honorary than remunerative, was changed in 1874 to Manager, the Government then taking over the Gardens. Mr. Niven retained charge until the arrival of Mr. James Murton in 1875.

W. MAKEPEACE.

**A Guide to the Palm Collection in the Botanic
Gardens, Singapore.**

But two brief notes have so far been published on the fine collection of Palms growing in the Botanic Gardens, Singapore. The first in the "Agricultural Bulletin, S. and F. M. S." (Vol. III, p. 249) in 1904, the second in the same Journal (Vol. V, p. 6) in 1906, both presumably by Mr. Ridley. In the fourteen years since the last article was written many additions, and it is feared several losses, have to be recorded and accordingly it seemed desirable thoroughly to investigate the collection again. The present paper is the outcome of this work.

In the first paper of Mr. Ridley, entitled "The Palm Collection of the Botanic Gardens, Singapore," the cultivation and pests of the palms has been rather fully treated, and a list of the palms

in cultivation in the Gardens is appended. In the second paper is a list of new palms introduced into the collection since the publication of the earlier paper.

The present paper is written with the object of drawing attention to the collection and in providing a guide and brief description for visitors to the Gardens, who are interested in Palms. It has been written in a semipopular style accordingly and botanical terminology, synonymy, and citations of other works are given as sparingly as possible. A short description of the collection is first given with a general comparison of the prominent features of the palms. This is followed by a list of the genera represented and a brief note on each species, sufficient to enable them to be determined at sight.

Only those species whose identity has been established either from actual determination or from previous records as found on the labels have been mentioned. There are still several not yet named, many of them quite young, but until they produce flowers and fruit it is impossible to determine them accurately and they have accordingly been omitted.

The collection of palms is quite a representative one, including species from most tropical countries. No special arrangement, except in one or two instances, has been followed in planting and the result is by no means displeasing. A fairly large piece of ground near the Gardens Office, has been exclusively planted up with palms, and from the lower end of Maranta Avenue down to the Plant Nursery there extends what is known as the Palm Valley, and as the name implies, the valley has been reserved almost entirely for palm specimens. On the west side, several species have been quite successfully planted in clumps, notably—*Ptychosperma McArthurii*, Wendl., *Cyrtostachys Lakka*, Becc., *Martinezia caryotaefolia*, H. B. K., *Pinanga Kuhlii*, Bl., *Rhopaloblaste hexandra*, Scheff., *Oncosperma filamentosa*, Bl., *Heterospathe elata*, Scheff., *Oreodoxa regia*, H. B. K., *Stevensonia grandifolia*, Dunc., *Versaffeltia splendida*, Wendl., *Ptychoraphis angusta*, Becc.

Apart from these two special places, many specimens are scattered over the remainder of the Gardens. Small avenues have been planted in one or two places, as for example, the avenue of *Arenga saccharifera*, Labill., near the Tyersall Road entrance. There is also an avenue of *Sabal Palmello*, Lodd., another not quite complete of *Rhopaloblaste hexandra*, Scheff., interplanted with *Phoenix rupicola*, Anders. This latter gives quite a pleasing effect, the tall *Rhopaloblaste hexandra* with its drooping leaflets, and the beautiful curved leaves of *Phoenix rupicola*, make a very pretty picture. Another avenue which must be mentioned, is of *Cyrtostachys Lakka*, Becc., the "Pinang Rajah," "Sealing Wax Palm," or "Red-stemmed Palm." This avenue contains fine specimens of this beautiful palm, so distinct from all others on account of what appears to be a red stem, but is actually the red sheathing bases of the leaves. The remaining plants have either

been planted in rows of single species, or more generally as isolated plants with a view to their developing into worthy representatives of their species. On the whole this latter ideal has been attained and a few very fine specimens might be mentioned such as, *Attalea Cohune*, Mart., near the lake, *Corypha Gebanga*, Bl., near the Herbarium, a young plant of *Latania Commersonii*, L., near the Office, and two very tall specimens of *Livistona altissima*, Zoll., on the Bandstand Hill, and many specimens of *Oncosperma filamentosa*, Bl. (Nibong) and *Elaeis guineensis*, Jacq. Altogether there are about 1085 specimens planted in the Gardens embracing upwards of 120 species and 60 genera.

A COMPARISON OF GENERAL CHARACTERS.

The variation in growth of the palms allows them to be grouped under three heads:—

- (1) Those which are soboliferous, that is whose stems grow in clumps such as *Caryota mitis*, Lour., *Cyrtostachys Lakka*, Becc., *Oncosperma filamentosa*, Bl.
- (2) Those which are soboliferous but are not self-supporting, obtaining their support from surrounding trees. This section includes the many species of *Calamus*, *Korthalsia* and *Daemonorops*, and amongst which are many plants of considerable economic importance. Some grow to a great height, topping the highest of our jungle trees. Examples may be seen in the piece of virgin jungle preserved in the gardens, especially at the top end of Maranta Avenue.
- (3) Those palms which are single-stemmed, bearing in some cases a magnificent crown of leaves as in *Corypha*, or in other cases a comparatively small one as in the tall *Livistonas*, and *Archontophoenix Alexandra*, Wendl.

A DESCRIPTION OF PALMS IN GENERAL.

ROOT. Generally speaking palms have no tap-roots. After germination the primary root perishes and is replaced by adventitious roots springing from the base of the stem. In *Versaffeltia splendida*, Wendl., roots are produced up to 2 or 3 ft., and even more above the surface of the ground. These grow downwards and finally become fixed in the soil giving the plant a firm footing. In others such as *Rhapis*, and *Pinanga*, suckers are produced which send up stems and leaves, soon forming fine clumps.

STEM. The height or length of the stem varies considerably and in some cases there is hardly any stem at all as in *Sabal acaulis*. In others however, they may be of any height or length, some specimens of *Calamus* being as much as 300 ft. Except for the last mentioned, no specimen in the Gardens exceeds 80 ft., this height being attained by two specimens of *Livistona altissima*, Zoll., on the Bandstand Hill. As a general rule single-stemmed palms attain to a greater height than soboliferous or several-stemmed palms. In diameter stems vary considerably, from 1-2 inches

in the slender *Calamus*, *Ptychosperma*, etc., to the very substantial looking trunks of *Oreodoxa*, *Metroxylon*, *Borassus*, and *Corypha*, which in some specimens are anything from 3-5 feet.

In *Oreodoxa regia*, H. B. K., the trunk is quite smooth, while in *Archontophoenix Alexandrae*, Wendl., it is ringed by the scars of the old leaves. Other species such as *Attalea Cohune*, Mart., and *Elaeis guineensis*, Jacq., retain the bases of the old leaves which gives them a rugged appearance. Ferns and orchids often obtain a footing in these leaf bases presenting a typically tropical effect. In *Caryota urens*, L., the sheathing bases remain round the stem after the leaves have fallen and are bound together with a dense mass of fibres. Yet other palms have spiny trunks as for example, *Oncosperma horrida*, Scheff., and *O. fasciculata*, Thw.

Very few of the palms have branched trunks. One species *Hyphaene indica*, Becc., is represented in the gardens, but the plants are quite small and are only about six months old.

The Rattans (*Calamus*, etc.,) are almost the only palms whose stems are not self-supporting.

LEAF. As new leaves are produced the old leaves generally die off and fall away. By this means in most cases a fine trunk is produced, surmounted by a magnificent crown of leaves. It is this crown of leaves which gives such a distinctive beauty to palms in general. They vary considerably in size, from the small-leaved *Rhapis flabelliformis*, L'Herit, to the gigantic leaved *Teysmannia altifrons*, Miq.

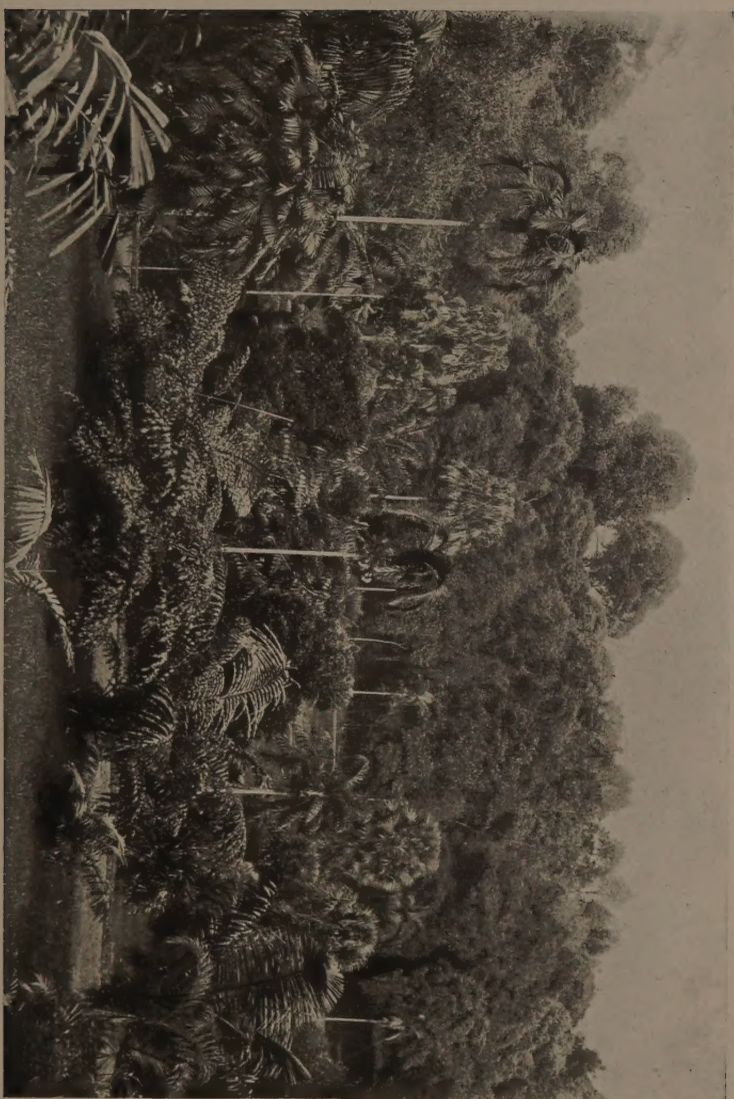
The variation in the shape of the leaf is considerable, but may be considered under two heads:—

- (1) Palmate, in which the leaves are characteristically fan-shaped and
- (2) Pinnate, in which the leaves are cut similar to a feather.

Examples of the first are *Livistona*, and *Thrinax*, of the latter *Ptychosperma*, *Cyrtostachys*, and *Oncosperma*.

Feather leaved palms have on the whole very much larger leaves than fan palms. The length of some of them being as much as 30 ft., and their width 8 ft. However, none quite so large are to be seen at present in the Gardens. The angle which the leaf makes with the stem varies according to the age of the leaf. At first when opening, a leaf is almost upright, but as it develops its weight bends it down and the falling away of the lower leaves causes it to hang lower until it in its turn dies and falls away. The leaves of fan palms as a rule form a larger angle with the stem than those of the feather palms. The reason being, that the weight is less evenly distributed, being placed at the end of the petiole, instead of almost the whole length of the leaf as in the latter.

Considerable variation is found in the leaflets. In the pinnate section their relative positions on the leaf-rachis give a distinctive appearance to many species. A few examples in both sections will emphasize this. In the palmate section, one finds in *Pritchardia*



In the Palm valley, Singapore.

grandis. Seem., that the whole of the leaflets seem to be joined up to form one deeply furrowed leaf, having a very strongly-toothed margin. Other species of the same genus *L. peltata*, Roxb., for example are divided almost to the base, producing furrowed leaflets which are very broad and strongly toothed at the apex, narrowing to the base, giving them almost a triangular shape. Good examples of fan-leaves are found in *Thrinar* and *Livistona* in which they are divided from $\frac{1}{4}$ to $\frac{1}{2}$ the length of the leaf. This is the general type of fan-palm.

In the pinnate section the angle which the leaflet forms with the leaf-rachis varies considerably. For instance in *Archontophoenix*, and *Cyrtostachys*, the leaflet is placed more or less at right angles to the rachis forming a fairly flat-leaf. On the other hand in *Rhopaloblaste* and *Oncosperma*, the angle is much greater giving a drooping appearance which is very attractive. The leaflets are generally arranged in two rows one each side the rachis, and as they are more or less opposite, they produce a flat leaf. This is the general arrangement for pinnate-leaved palms. A departure from this method is found in some species, as for instance in *Raphia Hookeri*, M. and W.. Here the leaflets appear to be arranged in four rows, two each side of the rachis. This is due to their being placed at different angles. The two bottom rows, one each side of the rachis, consist of alternate twos or threes placed at the usual angle, while the two upper rows, are the remaining leaflets placed at a very much more acute angle, thus giving the appearance of four rows, whereas in reality there are but two. This arrangement gives a very different appearance to this type of palm, and one fine specimen in the gardens makes a noble-looking plant. Another very distinctive form is that of *Caryota urens*, L. In this species the leaves are bipinnate or decompound, quite an unusual form in the palm-family. In fact this plant appears more like a gigantic tree-fern. One other genus should be mentioned, namely, *Martinezia* from America. In *M. caryotaefolia*, H. B. K., the leaflets, which are of peculiar shape, are placed at intervals in threes and fours on the rachis, the spaces between being clothed with very sharp spines.

The petioles of several species are armed with spines. When allied with spiny stems they form a very formidable barrier in the jungle. Mention has been made of the spiny leaf-rachis of *Martinezia*, this plant has also a very spiny stem. The same combination is found in *Oncosperma horrida*, Scheff., though the leaf-rachis of this species is not so spiny as that of *Martinezia*. Many palms have spines on the petiole only, such as *Livistona*, and *Elaeis*.

The stems and leaves of *Calamus*, and *Korthalsia*, are generally provided with numerous recurved spines, and the leaf rachis is often produced into a barbed, whip-like structure. These spines which are reflexed enable the plants to climb over the surrounding shrubs and to the tops of the highest trees.

The many different positions assumed by the leaves are often taken up to protect the plants from the effects of too intensive

sunlight and the violence of wind and rain. This arrangement adds very much in some cases to the beauty of the plant. *Phoenix rupicola*, Anders., affords an excellent example. The curve affected by the leaves of this plant renders it more beautiful than would be the case were the leaves straight.

FLOWERS. These are produced in large numbers on large and much-branched inflorescences. They are frequently embedded in the fleshy surface of the branches, and belong to a type of inflorescence known as a spadix. In almost all palms the inflorescences are axillary, only in one or two cases are they produced terminally, as in *Metroxylon*, and *Corypha*. Each inflorescence when in bud, is enclosed in a protective structure called a spathe. This is burst by the growing inflorescence and falls off at once, or sometimes remains to sheathe the stalk and lower branches. The flowers are very small and individually insignificant, but are produced in enormous quantities, thousands often being borne on one inflorescence. Collectively they often present a handsome appearance. They are sessile, and as a rule unisexual, the male and female occupying different parts of the same inflorescence. Very rarely hermaphrodite flowers are produced. In some cases female flowers are borne on the lower branches of the spadix with the male flowers densely packed on the upper. In others as for example in *Pinanga* the female flowers are placed between the male flowers and it is so arranged that two male flowers appear in succession and then the female, thereby making the spike unisexual for the time being. As palms are monocotyledonous plants the general arrangement of the flower is trimerous, that is 3 sepals, 3 petals, 6, or a multiple, stamens, and 3 carpels. In the male flowers the carpels are rudimentary and are called pistillodes and in the female flowers the stamens are rudimentary and are termed staminodes. Pollen is produced in great quantities and probably wind is one of the chief agents in pollination. Bees also play an important part in this matter. Also the writer has seen flower spikes literally swarming with a large type of ant and it seems probable that pollination might be carried out by them. The ovary generally consists of three carpels either quite free or completely united.

FRUIT. The fruit is either a berry or a drupe. Two of the carpels may be abortive as in the Coconut, or if the carpels are free, a syncarp of one-seeded fruits results, or again if united, a single fruit with one, two or three seeds, according to the number of ovules which develop is the result. The fruits are on the whole small when compared with the size of the plant, that of the Coconut being one of the largest. This is, however, quite dwarfed by the huge fruit of the Double Coconut (*Lodoicea sechellarum*, Labill.), from the Seychelles.

SEEDS. The seeds are of various shapes and sizes. They are round in the Coconut, owing to one ovule only as a rule having developed, whilst in the Date, (*Phoenix dactylifera*, L.), they are long and narrow. Where three seeds are produced two sides are often flattened.

CULTIVATION. A few notes on the general cultivation and propagation of palms in the tropics would it is thought be of use. This has been fully dealt with in "The Agricultural Bulletin S. and F. M. S.," Vol. III, page 250. The following extract is taken from that journal as the notes there given are equally applicable now.

"Although far the greater number of palms are natives of tropical regions a small number inhabit cooler, sub-tropical, or almost temperate regions. Such are *Chamaerops humilis* of Southern Europe, *Nannorhops Ritchieana* of Afghanistan, *Trachycarpus excelsus* of Japan, *Rhapis humilis* of Japan, *Kentia sapida* of New Zealand, and *Pseudophoenix Sargentii* of Florida.

"These cooler climate palms are much less easy to cultivate here and seldom thrive when planted out, although they may be kept as pot or tub plants for a long time.

"There are also a few desert palms, which are also difficult to grow on account of our heavy rainfall, such are *Hyphaenes*, the common date, (*Phoenix dactylifera*), which, however, can be made to grow but has never flowered with us. The Palmyra or Lontar palm (*Borassus*) introduced to India from Africa and thence to the Peninsula, thrives near the sea in sandy places, but seems difficult to grow far inland, and even in the drier parts of Singapore is not at all easy to grow satisfactorily. The Nipa palm so abundant in the tidal swamps does not grow well away from salt mud.

"Exclusive of these almost all the palms from different parts of the world which have been introduced into Singapore have done well and many have flowered and fruited successfully and are readily cultivated.

"**SEEDS.** Generally speaking palms are reproduced from seeds, in a few instances propagation by means of division or root cuttings is the method adopted. The principal genera from which root cuttings may be obtained are:—*Pinanga*, *Cyrtostachys*, *Oncosperma*, *Iriarteia*, *Oenocarpus*, *Chamaedorea*, *Chrysalidocarpus*, *Wallichia*, *Arenga*, *Caryota*, *Nipa*, *Licuala*, *Rhapis*, *Calamus*, *Zalacca*, *Korthalsia*, *Raphia*, *Bactris*, *Desmorcus*, *Astrocaryum*, and *Sagus*. With these an underground creeping rhizome produces a new growth and it is best to cut or ring this rhizome behind the growth and when a tuft of roots has been formed the cutting may be removed. Root cuttings, however, seldom make nice shapely plants, the process is usually a slow one and the percentage of loss generally heavy, for these reasons when procurable seeds are always preferred.

"In collecting palm seeds it is essential that the seed should be perfectly ripe. This is generally easily determined by the hardness of the seed, that is to say of the albumen, and also by the colour and softness of the fruit, occasionally the albumen seems to be fairly hard before the fruit is ripe enough to germinate. The colour of the fruit is often a help, thus, in *Iguanura* the fruit is first white, then becomes red, and at last black, and when it has arrived at this colour only it is ripe enough for collecting.

"The fruits of palms may be fleshy, fibrous or even woody, and a few have a spiny spathe which has to be guarded against. Fleshy fruits soon ferment and the pulp is easily removed. Fibrous fruits may be macerated for a day or two when the outer covering can be split or peeled off. The Malayan "Kabong" is one of the worst to handle, the juice from the fruits being a skin poison. The Kitool (*Caryota urens*) is also a powerful irritant on the skin. Many palms germinate freely when left to themselves, under cultivation however it is best to remove the outer covering of the seed because of the decay of the pulp or fibrous covering and possible loss from fungus. The period of germination varies from 6 weeks with some to 3 or 4 years with others. Excepting, those palms requiring much space, Coconuts, Sago, it is best to plant seeds in pots or boxes, whichever is used the drainage should be deep and well covered with half decayed leaves to prevent the compost from blocking up the drainage. The compost to be used should be free from fungi and consist of burnt earth, well decayed leaf-mould, some sand, and a little powdered charcoal. Seeds may be planted fairly close, small seeds placed upright, large seeds on one side, or flat, and covered with one-half to one inch of the prepared compost which has been passed through a sieve of a fine mesh. After planting the pots or boxes should be thoroughly watered (saturated) placed in a moderately damp situation and afterwards sufficiently sprinkled so as never to be over wet or too dry. Palm seeds when planted must be guarded from rats and mice, and white ants, the surface soil inspected, and excessive damp and fungus removed. The growth is often at first very slow (this is especially noticeable in rattans) but after a year or two the growth increases much more rapidly.

"SEEDLINGS. With most of the best known palms seedlings may be described as fairly hardy and only ordinary attention is necessary to produce strong plants, most failures occur through excessive damp or watering, and the moisture remaining in the axils of the leaves, or because the surface soil is too damp in which case the seedling perishes. A few species of palms have been introduced to cultivation by seedlings collected in the jungle of which seeds have not been procurable. Owing to the different conditions under which such seedlings have germinated care must be taken to wrap the roots in mud immediately on lifting them and the seedlings dug up with a good ball of earth attached to them. The little plants must be kept very moist till they can be planted, and not allowed to get dry by exposure to the sun or they speedily perish. Some jungle palms stand transport fairly well, especially rattans and with some species it is the only way to get them.

"RE-POTTING. As soon as seedling palms have filled their pots with roots, the young plants should be transplanted or repotted into single pots and a strong compost used. Some loamy soil, well decayed cow manure and leaf-mould, some sand and burnt earth, all well mixed together and passed through a moderately coarse sieve. Let the drainage be sufficient and placed carefully. All loose

and old sour soil removed from the plants, the roots inspected if sound and free from pests, keep lightly syringed for a few days and water sparingly until the plants are established. Palms succeed best when potted or planted deeply, unlike flowering plants the lower roots of palms in thickening raise the plant, and the surface or adventitious roots grow upwards. In repotting or tubbing very strong plants of which the roots have become tightly bound together it is not necessary to disturb the ball or place new drainage underneath it, but a little additional drainage could be placed round the base, and though the plants may appear deeply tubbed at first the surface roots will soon appear on the top."

SELECTION OF SPECIES. The decorative value of palms is so great as to merit their being placed high in the list of decorative plants. The following hints are given with a view to assisting in selection and planting. Having obtained good strong plants, the question arises as to what should be done with them to obtain the best results. This is important as in the case of plants required for household decoration and around the bungalow, it is imperative that the species which make the best pot plants are chosen. In addition it is very necessary to know which species require shade and vice versa. This applies to garden planting generally.

POT PLANTS. For this purpose the following species are generally considered best.—*Phoenix rupicola*, Anders., *Thrinax argentea*, Lodd., *Thrinax barbadensis*, Lodd., *Licuala peltata*, Roxb., *Pritchardia grandis*, Seem., *Livistona australis*, Mart., *Livistona chinensis*, Br., *Livistona altissima*, Zoll., *Calamus Lindenii*, Hort., *Caryota mitis*, Lour., *Arenga Engleri*, Becc., *Hyophorbe amari-caulis*, Mart., *Heterospatha elata*, Scheff., *Verschaffeltia splendida*, Wendl., *Ptychosperma McArthurii*, Wendl., *Ptychosperma Sanderiana*, Ridl., *Elaeis guineensis*, Jacq., *Cocos plumosa*, Lodd., *Martinezia caryotaefolia*, H. B. K., *Stevensonia grandifolia*, Dunc., *Rhopaloblaste hexandra*, Scheff., *Chrysalidocarpus lutescens*, Wendl.

Shade is necessary for *Pritchardia grandis*, Seem. and *Ptychosperma Sanderiana*, Ridl., a little shade is appreciated by the majority of the others.

All the above when they have grown too large for pots or tubs, can be planted out in situations which follow the lines already laid down as regards shade.

SPECIMEN PLANTS. The following species are recommended for planting out in the grounds as specimen plants.—

(a) Several-stemmed species—*Chrysalidocarpus lutescens*, Wendl., *Rhapis flabelliformis*, L'Herit., *Caryota mitis*, Lour., *Arenga undulataefolia*, Becc., *Oncosperma filamentosa*, Bl., *Cyrtostachys Lakka*, Becc., *Ptychosperma McArthurii*, Wendl. The above do not require much shade. Some of these species are particularly useful for filling in gaps and where a clump is desirable. It may be mentioned in passing that though very effective *Cyrtostachys Lakka*, Becc., the Pinang Rajah, is a rather slow grower.

Pinanga Kuhlii, Bl., *Pinanga patula*, Bl., and *Ptychosperma Sanderiana*, Ridl., require shade.

(b) Single-stemmed species—*Acanthorhiza aculeata*, Wendl., *Livistona altissima*, Zoll., *L. australis*, Mart., *Latania Commersonii*, L., *Caryota urens*, L., *Elaeis guineensis*, Jacq., *Cocos plumosa*, Lodd., *Martinezia caryotaefolia*, H. B. K., *Phoenix rupicola*, Anders., *Dypsis madagascariensis*, Hort., *Oreodora regia*, H. B. K., *Actinorhysis calapparia*, Wendl., *Dictyosperma album*, W. and D., *Archontophoenix Alexandrae*, Wendl. None of these require much shade.

AVENUE PLANTS. Many palms lend themselves for this kind of work and the following have proved very effective.—

Sabal palmetto, Lodd., *Caryota urens*, L., *Dypsis madagascariensis*, Hort., *Oreodora regia*, H. B. K., *Cocos plumosa*, Lodd., and *Arenga saccharifera*, Labill., all of which are sun rather than shade loving plants.

F. FLIPPANCE.

(To be continued).

THE FUNGUS FLORA OF HEVEA BRASILIENSIS.

A little while ago an enquiry was received asking what were the fungus diseases of *Hevea brasiliensis*. On consulting the literature on this subject it was ascertained that there was no recent complete enumeration of the diseases that have been found to attack this tree in Malaya. Such lists have been prepared for other countries, as for instance by Petch for the *Hevea* in Ceylon, but the diseases are not necessarily the same in different countries and it seemed desirable therefore to have a list for Malaya.

At the same time the present paper goes further than recording the diseases that have actually been proved and enumerates all fungi, both those that are known to be parasitic and those that are so far regarded as saprophytic, which have been found on *Hevea* locally.

The importance of having such a list is ably reasoned by Professor C. F. Baker in Vol. II, No. 4 of the "Gardens Bulletin," in his article "Hevea versus Fungi."

The records from which this compilation is made are the works and collections of H. N. Ridley, W. J. Gallagher, K. Bancroft, A. Sharples, W. N. C. Belgrave, R. M. Richards, and C. F. Baker.

It is considered that additions will have to be made to this list from time to time as further investigations produce new records.

Ridley in "The Agricultural Bulletin, Straits Settlements and Federated Malay States," Vol. X, 1911, page 141, quoting M. George Vernet gives on page 143 "a list of all pests recorded to the plant," and numerates 25 species of fungus, ending with the comment, "This may seem a formidable list but it is really small compared with the pests which attract most cultivated plants."

The same remark may equally well apply to the present list but it is to be hoped that the latter part of it may now be modified considerably. One might indeed at first wonder whether the *Hevea* tree would grow at all under the burden of such a number of uninvited guests, and so far no other kind of tree in Malaya has so many fungi observed on it. It must be remembered however that the chief reason so many fungi are here recorded is that so much individual attention has been paid to the *Hevea* by Malayan mycologists. There is no doubt that an equally large number of fungi would be found on any other tree grown under similar conditions and studied so assiduously and sympathetically by experts.

In the present list the fungi are grouped according to their respective habitats. It will be seen that all parts of the tree carry their quota and that all the great groups of fungi are represented.

ROOT AND COLLAR.

Fomes lignosus, Klotsch (*Polyporaceae*). An orange coloured bracket fungus, probably the best known of rubber diseases. Previously, this fungus was known as *F. semitostus*, Sacc, owing to a wrong determination in the first instance. The first specimens in Malay were collected by Ridley in 1896 and forwarded to Kew. Considerable work has been carried out in connection with it chiefly by Gallagher and Bancroft, and is published in the bulletin of the Department of Agriculture, Federated Malay States.

Fomes pseudoferreus, Wakefield (*Polyporaceae*). The "Wet Rot" of *Hevea*, previously described under *Poria hypolateritia*. Investigated by Belgrave in 1917-1919.

Helicobasidium, (?) *H. mompa*, Tanaka (*Thelephoraceae*). The specimens which were collected by Ridley in Selangor in 1901 were sterile, and could not be definitely determined. Massee considered them a species of *Helicobasidium* probably *H. mompa* which is very destructive to the mulberry in Japan. No further collections of this fungus have been recorded.

Hymenochaete noxia, Berk. (*Thelephoraceae*). A common brown root disease.

Irpex flavus, Klotsch. (*Hydnaceae*). A bright yellow woody fungus first collected on rubber by Ridley in 1897. Bancroft's investigations are published in the bulletins of the Department of Agriculture Federated Malay States. It is considered to be parasitic.

Marasmius rotalis, B. et Br. (*Agricaceae*). Bancroft records the mycelium of this fungus as occurring at the base of trees, like "horse hair."

Poria hypolaterita, Berk. (*Polyporaceae*). Investigated by Belgrave and originally determined as this species at Ceylon. Later a re-determination has referred the specimens to *Fomes pseudoferreus*.

Ustulina zonata, Sacc. (*Sphaeriaceae*). A black crustaceous fungus which attacks the trees at their collar causing loss of foliage

and "die back." Investigated by Brooks and Sharples and recorded in the bulletins of the Agricultural Department, Federated Malay States.

Xylaria cynoglossa, Cooke (*Sphaeriaceae*). A small pale coloured tongue-shaped fungus recorded by Bancroft.

STEM AND BRANCHES.

Apiosporium atrum, Massee (*Perisporiaceae*). Found on dead branches. Bancroft does not consider it a parasite.

Asterina tenuissima, Petch, (*Perisporiaceae*). Petch considers that this mould lives on the sugary secretions of the nectaries at the base of the leaves.

Botryodiplodia theobromae, Pat. (*Sphaerioidaceae*). Reported by R. M. Richards as a cause of "Dieback."

Cephalosporium, sp. (*Mucedinaceae*). Recorded by Belgrave as one of the fungi present in "mouldy rot" on tapped surfaces. He also found it a parasite on *Hemilea vastatrix*.

Corticium calceum, Fries, (*Thelephoraceae*). A bark fungus determined by Massee in 1906.

Corticium javanicum, Zimm. (*Thelephoraceae*). A cause of "Pink Disease."

Corticium salmonicolor, B. et Br. (*Thelephoraceae*). The cause of "Pink Disease." Described in detail by Brooks and Sharples in the bulletins of the Agricultural Department, Federated Malay States.

Cryptovalsa microspora, Sacc. (*Sphaeriaceae*). A new species found by C. F. Baker on rotting stems.

Gyphella heveae, Massee (*Thelephoraceae*). A cause of "Thread blight." Found on the bark by R. M. Richards.

Daldinia concentrica, Ces. et De Not. (*Sphaeriaceae*). A dark chocolate coloured bun shaped fungus forming hard globular masses, occurring commonly on dead wood.

Daldinia concentrica, Ces. var. *escholzii*, Ehrenb. (*Sphaeriaceae*). Found on a dead trunk.

Didymella oligospora, Sacc. (*Sphaeriaceae*). Recorded by C. F. Baker on dead branches.

Diplodia rapax, Massee (*Sphaerioidaceae*). Described by Ridley as a "pestilential black fungus" and named by Massee in 1909.

Diplodia, sp. (*Sphaerioidaceae*). The cause of "Die Back." It is considered to be a wound parasite, that is to say, it can only enter its host through a dead or wounded part. The fungus itself is scarcely visible to the naked eye, and is in the form of minute black dots on the dead shoots.

Eutypa caulivora, Massee, (*Sphaeriaceae*). This fungus forms numerous large black blotches on the trunk and is considered by Massee to be a parasite. Bancroft suggests it is a "wound parasite," and quotes Petch as stating that this fungus is the same as *Nummularia pithodes*.

Eutypa ludibunda, Sacc. var. *heveana*, Sacc. (*Sphaeriaceae*). Recorded by C. F. Baker on dead limbs.

Gloeosporium alborubrum, Petch (*Melanconiaceae*). Reported on dead shoots.

Hirneola polytricha, Mont. (*Tremellaceae*). A thin dark coloured fleshy fungus occurring in clusters at the ends of dead branches or wounded parts.

Hypochnus, sp. (*Thelephoraceae*). A "thread blight" fungus.

Hypoxyton oodes, B. et. Br. (*Sphaeriaceae*). A black nodular incrusting fungus reported by Bancroft on dead branches.

Hysterium heveanum, Sacc. (*Hysteriaceae*). On dead limbs.

Lembosia glonioides, Sacc. (*Hysteriaceae*). On dead limbs.

Megalonectria pseudotricha, Speg. (*Hypocreaceae*). Bancroft describes this as a bright red minute fungus forming small round bodies the size of a pin's head. It occurs on dead bark and stems. Brooks states that *Stilbum cinnabarinum* is the conidial stage of this fungus.

Nectria diversispora, Petch (*Hypocreaceae*). A common small red fungus, saprophytic on dead bark and fruits.

Nectria sanguinea, Fries (*Hypocreaceae*). An orange red saprophytic fungus found on the bark.

Neotrotteria pulchella, Sacc. Found on the bark by C. F. Baker and described by Saccardo as a new species.

Nummularia pithodes, Petch (*Sphaeriaceae*). Reported by Brooks and Bancroft to be common on dead branches and roots. It is one of the causes of black lines in the wood. Its black fructification has the appearance of a piece of asphalt. Petch considers *Eutypa caulivora* Massee, to be the same thing.

Nummularia repandoides, Fuck. var. *singaporensis*, Sacc. (*Sphaeriaceae*). On dead limbs.

Oospora gilva, Berk. (*Mucedinaceae*). A pink powdery fungus recorded by Bancroft as occurring commonly on burnt rubber stems.

Peroneutypa heteracanthoides, Sacc. (*Sphaeriaceae*). Recorded by C. F. Baker on dead limbs.

Phyllosticta heveae, Limm. (*Sphaerioidaceae*). A disease affecting the youngest shoots and widely spread throughout the country. It is closely associated with the "die back" fungus, and Bancroft considers that in many cases of the "die back" disease the primary cause is this fungus.

Phyllosticta ramicola, Petch (*Sphaerioidaceae*). Recorded by Bancroft as a stem disease.

Phytophythora Faberi, Maub. and P. spp. (*Perenosporaceae*). Very common and destructive parasites credited with causing "Black Thread," "Stripe Canker," "Cambium Rot," and canker of the bark.

Pleonectria heveana, Sacc. (*Hypocreaceae*). On rotting stems.

Polystictus sanguineus, Fries (*Polyporaceae*). The most brilliant coloured and one of the prettiest of Malayan bracket fungi. Its colour varies from a brilliant scarlet to dark blood red. It grows on all dead wood very commonly everywhere.

Schizophyllum commune, Fr. (*Agaricaceae*). A small mushroom with a lateral stipe growing in patches over dead wood. When wet it is a fleshy colour and expanded but when dry it turns white and the edges become involute. It is densely covered with hairs and is to be found on almost any dead wood.

Sphaeronema, sp. (*Sphaerioidaceae*). Reported by Belgrave to be the cause of "mouldy rot" on the tapped surfaces.

Stilbella heveae, Limm. (*Stilbaceae*). A minute pin shaped fungus with a salmon coloured head and dark coloured stalk. Reported by Bancroft on dead bark.

Stilbum cinnabarinum, (Mont.) Lind. (*Stilbaceae*). On dead parts, reported by Brooks to be the conidial stage of *Megalonectria pseudotrichia*.

Thyridaria tarda, Bancroft (*Sphaeriaceae*). Considered by Bancroft as the perfect stage of the "Diplodia" fungus, the cause of "die back." Vincens of Saigon also does not think this should be separated from *Diplodia*.

Xylaria obovata, Berk. (*Sphaeriaceae*). On stumps.

Xylaria scopiformis, Mont. (*Sphaeriaceae*). Recorded by Ridley and Bancroft on dead wood.

Xylaria tuberiformis, Berk. (*Sphaeriaceae*). Occurring on stumps.

LEAVES.

Helminthosporium heveae, Petch (*Dematiaceae*). Recorded by Ridley as attacking the young leaves and proving troublesome in nurseries.

Limacinia javanica, Sacc. (*Sphaeriaceae*). A sooty mould recorded by Bancroft as following on a scale, *Lecanium nigrum*. Such fungi live on the honey dew secreted by the insect and do not actually extract any food from the leaves, although their presence in masking the leaves is harmful in a young plant.

Pestalozzia Guepini, Desmaz (*Melanconiaceae*). This fungus first appears as small grey spots, more or less circular in shape. These spots enlarge and often coalesce and are bordered by a narrow black line. The fungus kills the chlorophyll and consequently causes the grey colour of the leaf. Recorded by Bancroft. This fungus is a very serious disease on tea.

Phyllosticta heveae, Limm. (*Sphaerioidaceae*). Recorded by Bancroft as a leaf parasite.

Sphaerella heveana, Sacc. (*Sphaeriaceae*). Recently collected on dead leaves by C. F. Baker, and considered a new species by Saccardo.

FRUIT.

Asterina tenuissima, Petch (*Perisporiaceae*). Recorded by Bancroft in 1913.

Nectria diversispora, Petch (*Hypocreaceae*). A small salmon coloured fungus on dead fruits.

PREPARED RUBBER.

Bacillus prodigiosus (*Bacteriaceae*). Reported by Bancroft as causing red spots on rubber crepe.

Chromosporium crustaceum, Sharp. (*Mucedinaceae*). Reported by Sharples as causing a black spotting in plantation crepe.

Eurotium candidum, Speg (*Perisporiaceae*). A common mould, reported by Bancroft. Sharples considers that the opaque spots on sheet might be attributed to this fungus.

Fusarium sp. (*Tuberculariaceae*). Stated by Sharples to cause a violet flush on sheet rubber. Previously Bancroft had stated this was due to *Bacillus violaceus*.

Monascus heterosporus, Schroeter (*Perisporiaceae*). Bancroft reports this fungus as causing a spotting on prepared rubber. Infection may take place from jungle wood both in the field or in the drying house.

Penicillium maculans, Sharp (*Mucedinaceae*). The cause of a yellow diffused flush on rubber. Investigated by Sharples.

Spondylocadium maculans, Bancroft (*Dematiaceae*). A cause of rubber spotting.

Trichoderma Koningi, Oud. et Konning (*Mucedinaceae*). Considered by Sharples as the cause of blue black spot on crepe.

The above was already written when an article entitled "Disease Scars" appeared in "The India-Rubber Journal" of 15th November 1919 page 21. The situation is well summed up in the first two paragraphs as follows:—

"We do not think that anyone could visit any part of the East without being impressed with the havoc which diseases have wrought on rubber trees. Even if a visitor to the tropics does not see many rubber estates he is fairly educated on the subject by the Eastern Press. There is a possibility that many individuals who have visited the East for the first time may be led to take an exaggerated view of the danger from diseases, so far as rubber estates are concerned. We do not, as our readers know, wish to minimise the importance of the subject in relation to the future of Eastern plantations but we feel bound to say that in many cases the number of trees affected on particular estates seem to bear some ratio to the activity of the Press and the number of investigators who have reported on the properties.

"Some estates which have not allowed mycologists to visit them declare that they are free from disease. While such a condition may be possible we have very grave doubts as to whether any pro-

perty of considerable age is free from the various bark and root diseases so prevalent throughout the East. We believe that on most plantations there are plenty of affected specimens to be found if the staff is free to search for them. We have generally found that the keener the managers and assistants are the larger the number of cases reported in the usual monthly statement."

It is a matter for consideration as to whether the term "Scares" should be applied to the recording of these diseases which are obviously always with us but only occasionally reported, according to the opportunity the scientist has to investigate them or as they assume undue prominence. They may probably provide a "Scare" for the outside man who is nervous and over anxious about his investment but they should hardly be considered in that light by competent experienced managers for with the assistance of these same scientists who record these diseases, they should feel quite capable of dealing with them and holding them in check.

T. F. CHIPP.

Tuba-Root (*Derris elliptica*).

AS AN INSECTICIDE.

Readers of George Maxwell's "In Malay Forests" will recollect the graphic account of a fishing expedition where the Malays used the root of the Tuba-plant as fish poison.

Many plants exist in the Tropics, and notably in India, which can be put to the same purpose of killing fish, and Watts' Dictionary gives a fairly long list of them. Throughout the Malay Archipelago Tuba-root appears to be the poison most in use, and a very effective one it is in the hands of expert natives.

The interesting question arises whether the toxic properties of this root are also effectual for the destruction of insect life; for, if such were the case, its application to agriculture is naturally all indicated.

The Chinese appear to have solved the question to their satisfaction, for we know that they employ tuba extensively for the protection of their crops against injurious insects. In Sarawak, the Chinese pepper planters always have, or had (for the writer's visit dates far back) a few bushes of tuba growing alongside their vines.*

Beyond that knowledge, however, the enquiry suggests itself whether the macerated tuba-root, as used by the Chinese, acts as a stomach-poison to chewing insects, when taken with their food, as it does in the case of grasshoppers and beetles, or as a contact poison for insects which obtain their food by sucking as bugs and plant-lice generally do, or whether its toxicity is effective both as a contact and a stomach poison.

* Tuba-root is now largely grown in Singapore.

The "Journal of Agricultural Research" of 15th August, 1919 published by the Secretary of Agriculture, Washington, has under the title "*Derris as an Insecticide*" an exhaustive article on the subject, and some of its tests and conclusions are given below.

But first, to prepare the ground, the writer may be permitted to give his own experience in the use of tuba-root in the course of his cultural work.

A believer in the orthodox standard sprays and emulsions found in text-books, the writer had only once casually tried tuba-root and that without any notable result. He gave it no further thought until, in the presence of the wholesale and persistent destruction of his bean-plots under the attacks of "*Agromyza phaseoli*" he was persuaded to give tuba a thorough and well controlled trial.

"*Agromyza phaseoli*," a fly, deposits its eggs under the skin of the stem of the beans, a very few days after germination of the seeds: the larvae feed on the tender tissues of the stems just below the first pair of leaves: the skin a week or so after germination, turns from green to brown and on pressing with the fingers, it is found to be hollow: the leaves fade and drop, and on splitting open the little stem, the small yellow larvae are found imbedded in the destroyed tissue.

Every plot was attacked and such is the virulence of this pest that it is quite an exception for one plant in 20 to survive. Among the many remedies employed against the pest were the following:—

Steeping the seeds in a 5% solution of corrosive sublimate. Rubbing the young stems with lime and powdered sulphur. The application of tobacco dust. Rubbing the seeds in sifted earth sprinkled over with "neem-oil" and putting some of this earth in each hole at the time of sowing.

The last device, alone, proved, to some extent, effective—about 20% of the plants being saved.

A trial of tuba was then made on a field of 8 beds, 66 feet long, with 1056 seeds of Lima Bean (Small Siéva) on the 28th October 1919. Ten ounces of tuba-root were well pounded in a wooden mortar, the juice thoroughly expressed, and the fibre exhausted in 20 gallons of water.

Tuba-water was then applied to each young plant at the rate of a cigarette tin full to 4 plants, morning and evening. This was continued for 15 days, until the plants were sufficiently established to be past all danger, which is only present during the first stage of their existence, when the stem is quite tender.

Only 16 seeds failed to germinate and of the 1040 plants that came up, not one has since died. And to-day, the plot is showing the most vigorous growth, a living testimony to the potency of the tuba-root as a plant-insect killer.

A point worthy of notice is that the "*Agromyza*" fly is there still quite manifest, and every morning, it can be seen in numbers flitting round and about the plants which it still damages to some extent: the pest has not died, but it has been completely prevented from laying its eggs in the young stems. The saving of the leaves, which it perforates to a state of fine lace, is not, by any means, an easy matter, but failing tuba-root, it is hoped, by means of sulphur dustings in the early mornings, gradually to overcome it.

The Tuba-plant "*Derris elliptica*;" in Malay *Akar Tuba*, a leguminose, may be seen growing in the Economic Gardens, as a low bush, but it is a climbing plant with a short trunk and long trailing branches. The root system is extensive and among the bundles of "*akar tuba*" sold in Chinese shops, pieces of root 8 feet long are not uncommonly found. In digging for roots in the Economic Gardens, the longest, so far found, was 5 feet in length: this shortness may be due to the unsuitability of the soil in which it grows—a soil too sandy to retain moisture in hot dry weather. According to a Chinese informant, tuba should be planted not far from water, which attracts the roots, thus favouring early development, and more frequent cuttings.

It is to be noted that the trials related in the Journal of Agricultural Research were made with dried imported roots, which implies, judging from the effects recorded, that it loses none of its potency by keeping.

Long tables are given in the course of the article with details of tests of tuba root applied as a dry powder and as a spray mixture with and without soap.

The following extracts are taken from this paper. A test was made of the effects of tuba as a contact poison on *Aphids*, with a spray mixture of 1 pound of powder to 100 gallons of water with the following results:

Number of	Percentage of Aphids living on plants at the end of						
	1st day	2nd day	3rd day	5th day	6th day	7th day	8th day
Aphids treated							
182	52.2	24.7	10.4	4.4	2.2	0.5	0.5
150	25.3	22.6	7.3	2.0	2.0	0.0	0
209	19.1	11.0	9.0	8.1	5.7	3.3	2.8
172	33.7	20.3	23.2	19.7	19.7	18.6	12.7
Average	35.0	19.6	12.7	8.5	7.4	5.6	4.0
Aphids untreated							
159	96	105.6	104.4	137.1	144.6	169.7	235.2

TEST WITH TUBA POWDER USED AS A DUST.

Number of	Percentage of Aphids living on the plants at the end of							
	1st day	2nd day	3rd day	4th day	6th day	10th day	13th day	15th day
Aphids treated								
96	43.7	36.4	31.2	16.6	3.1	0.0	0.0	0.0
157	38.4	21.0	6.3	2.5	.6	0.0	0.0	0.0
111	49.5	29.7	11.7	9.0	4.5	.9	.9	0.0
235	47.6	31.0	16.5	15.3	9.7	1.2	.4	0.0
Aphids untreated	44.8	29.5	16.4	10.8	4.5	0.5	0.3	0.0
180	103.3	129.3	146.1	179.4	231.6	315.5	315.5	3155+

These tables (two out of many) are followed with the remark:

"Reference to the two tables shows that the percentage of untreated "Aphis" gradually increased from the first day of the tests onward. The increase was due to the birth of new "Aphids on the untreated plants. Aphids were also born on the treated plants from the time the insecticide was applied, until the reproducing mothers had died. Since, practically, all the "Aphids on the treated plants were dead at the close of the tests, the newly born young ones must have been killed by coming in close proximity to the particles of powder still remaining on the plants."

EFFICIENCY OF "TUBA" AS A STOMACH POISON AGAINST VARIOUS INSECTS.

Potato Beetle larvae. Tuba used in various strengths up to 1 pound of powder to 128 galls. of water was found very effective. Practically all larvae were killed within 48 hours. Applied as dust the tests were equally conclusive.

Tent Caterpillars. All mixtures varying in strength from one pound to 8 gallons of water to 1 pound to 200 gallons were found effective.

Apple-tree branches were thoroughly sprayed and, after the foliage had dried, 20 to 40 newly hatched larvae were placed on each branch. The caterpillars began to show signs of discomfort within 48 hours and were practically all dead in from 5 to 10 days. In no case, was any material amount of feeding observed. In a second series of tests the larvae were placed on the branches and

sprayed after they had begun to form their tents. Under these conditions, sprays containing one pound of powder to 50 gallons of water and 1 pound to 100 gallons, killed all the larvae within 24 hours. When 1 pound to 200 gallons and 1 pound to 400 gallons of water were used, all the larvae were not killed within 11 days, but the few which remained alive were very small and inactive.

Used as a dust, this material killed all the treated larvae within a week.

Oak-Worms. Two small oak trees, on which about 300 caterpillars (*Anisota Senatoria*) were feeding, were sprayed thoroughly with Tuba at the rate of 1 pound of powder to 25 gallons of water: soap was added at the rate of one pound to 50 gallons, and a knapsack-sprayer was used. Within 24 hours, the larvae became inactive and ceased to feed, and at the end of 6 days no living ones could be found. As a check on this test, powdered arsenate of lead was applied at the rate of 1 pound to 50 gallons of water, and almost identical results were obtained.

Hyphantria Cunea (caterpillars which weave a web inside which they work, devouring the foliage enclosed). The caterpillars about one third grown, were killed within a week by a spray of 1 pound of powder to 5 gallons of water. Mixtures ranging from 1 pound to 50 gallons to 1 pound to 200 gallons of water were not satisfactorily effective, since nearly all of the sprayed foliage was eaten and not all of the caterpillars were killed.

Datana larvae. Two apple-trees, on which large colonies of nearly full-grown apple datanas (*Datana ministra*) were feeding, were sprayed with Tuba at the rate of 1 pound to 50 gallons of water. Twenty-four hours later, one living larva was found on one tree, and two on the other tree. The ground under the trees was thickly sprinkled with dead larvae.

Cabbage Worms. Applied at the rate of 1 pound to 25 gallons of water all the larvae in two cage-tests were killed within 24 hours.

Methods were employed to trace the tuba-powder and spray mixtures in the bodies of insects and the results show that tuba powder dusted upon insects does not pass into the tracheae, but a limited amount of it may lodge in the spiracles: in order that the vapours and exhalations from a spray be effective, it is necessary for the sprayed insects to carry some of the solution on their bodies, in order that the exhalation may pass into the spiracles in as undiluted a condition as possible. After being dusted the insects seem to swallow some of the power which later may act as a stomach poison. Soap solutions containing tuba extract pass freely into the spiracles and finally reach the various tissues, but probably the extract kills by first affecting the nerve-tissue. (The above physiological conclusions are based on microscopical examinations and chemical manipulations too long and too technical to be inserted in this paper).

CONCLUSIONS.

The preceding experiments, much abridged as they are here given, show that the toxic principle of the tuba-root kills insects by acting both as a contact and as a stomach poison. It kills some insects easily, and others with difficulty, but it usually acts slowly and seems to kill by motor paralysis.

The above tests were made under strict control at the Agricultural Boards Testing Laboratory of Vienna (Va). They put beyond dispute the efficacy of tuba-root as a plant-insect poison and give it a high place among agricultural insecticides.

E. MATHIEU.

The Angsana Tree.

Yet another avenue of the Angsana tree (*Pterocarpus indicus*) has succumbed to the "disease" that has already deprived this country of some of its finest avenues. It will be recalled by many how these avenues have disappeared one after the other, first the one on the sea front in Malacca, then about 1907 one hundred trees in Penang, followed by epidemics among these trees at Tapah, Kuala Kubu, Kuala Lumpor and Taiping. A short while ago the avenue along the sea front at Singapore was also swept away. At the end of May this year (1919) some trees at the end of an avenue at Tanglin Barracks, Singapore, began to show the well known symptoms. Four months afterwards the "disease" had advanced considerably along the Avenue, but not successively taking toll of every tree for occasionally one was omitted, but so many trees were affected that it was deemed necessary to cut the avenue down. A look-out was kept for fungi but there was no opportunity to make a detailed investigation of the tissues of the trees. The only fungus collected was one of the tropical varieties of *Polyporus* (*Ganoderma*) *lucidus*, sometimes a stipitate form and sometimes more unguiculate. This is interesting as the fungi formerly collected from these trees have been *Polystictus occidentalis*, Fr., *Polystictus floridanus*, Berk., *Schizophyllum commune*, Fr., and *Polystictus hirsutus*, Fr. So far no fungus has actually been observed in the tissue.

On the other hand it is understood that this tree is generally propagated by means of cuttings. Now there are some who hold that the reason of this tree dying off in the manner it does is a question of senile decay and not of disease. The theory put forward is that the age of the individual tree must be counted from the last time its stock was grown from a seed. It is quite likely this may be many generations and correspondingly a considerable number of years. It is also to be presumed that the avenues and groups of trees which die off at the same time, in the same localities, are planted from the same stock of cuttings and would therefore be approximately the same age. In view of this the following article taken from the Gardens Chronicle Vol. LXVI, No. 4111, page 190 is of interest.

"Mr. Benedict's interesting and valuable investigations on, the senile decay and loss of fruitfulness in plants contained material of special interest to fruit growers. Not the least interesting part of the paper is that in which he appeals to the opinion of that remarkable English horticulturist Thomas Andrew Knight, who, upwards of a century ago (1795) was occupied with this same problem of senility of plants. Knight in fact, came, as the result of his experiments with Apples and Pears, to the same conclusion as that reached by Mr. Benedict, and attributed to senility the gradual failure of different varieties of fruit trees. He found in his grafting experiments that the vigour of grafts was influenced by the age of the tree from which they were taken, and with the acumen of genius he appealed in support of his opinion to the common phenomena presented by certain woodland trees. He observes that certain of them, such as the Aspen, send up multitudes of root-suckers, and adds "were a tree capable of affording an internal succession of healthy plants from its roots, I think our woods must have been wholly over-run with those species of trees which propagate in this manner, as these scions from the roots always grow in the first three or four years with much greater rapidity than seedling plants.

"In another paper published in 1810 and entitled "On the Parts of Trees Primarily Impaired by Age." Knight makes the yet more remarkable comment:—"I am.....disposed to attribute the disease and debility of old age in trees to an inability to produce leaves which can efficiently execute their natural office. It is true that the leaves are naturally reproduced and therefore annually new, but there is, I conceive, a very essential difference between the new leaves of an old and of a young variety." This difference after over a hundred years, would seem to have been now demonstrated.

"It may be added that Mr. Benedict has extended his observations on the veining of young and old varieties, to fruits other than the vine and he found in the case of Apples, Pears, Plums and Peaches that increasing age is accompanied by the same concentration of small veins as occurs in the vine. Hence it would seem that it might be possible to ascertain approximately the age of a tree by an examination of one of its this year's leaves!

"Finally reference should be made to the interesting but purely speculative hypotheses of old age in plants which have been advanced. Of these hypotheses that of Metchnikoff deserves mention. It may be described as the "guilty organ" hypothesis, in that he ascribes old age to the failure of one organ of the body: in the human body the large intestine is the sinner; in annual plants Metchnikoff ascribes to the flower-head the guilt of producing toxins (poison) which destroy the vegetable parts.

"Another hypothesis ascribes senility to cell specialisation. On this an unspecialised cell is immortal, but a cell, the moment it becomes a specialist at certain kinds of work puts off immortality and becomes mortal; but against this view is the fact that a

differential plant cell may resume its powers of growth and division becoming once again embryonic and thereby resuming its immortality.

"Whatever be the final verdict on Mr. Benedict's discoveries we cannot but be grateful to him for getting away from words and appealing to facts. Nor will horticulturists be slow to accept the moral that it behoves us to go on producing new varieties by cross breeding, for whether or no all existing varieties are doomed sooner or later to old age, the fact remains that there is still room for improvement among all our cultivated varieties of fruits and plants generally."

It would be interesting to have authentic records of the behaviour of *Angsana* trees raised from seed.

T. F. CHIPP.

***Echinodia theobromae*, Pat.**

The following notes are in continuation of the article in the "Garden's Bulletin" Vol. II, No. 5, page 144. Further specimens of *Echinodia theobromae*, Pat. as described by Patouillard in the Bulletin de la Société Mycologique de France" Tome XXXIV, 2nd Fasc. have been obtained growing on small branches of a *Quercus* in the Botanic Gardens, Singapore. The smaller specimens agree entirely with the original description of Patouillard. In the larger specimens, which do not exceed 3 mm. in diameter, the older or generally middle portion of the specimens develops a typical polyporaceous tissue. The pores whose length is the same as the height of the plant, constitute the whole of the specimen except the thin crust of hyphae which is directly applied to the support, and the crust covering the outside edges of the specimens from which the stilboid fructifications arise. The transition from stilboid to porus formation is abrupt, the stilboid columns at the transition area quickly becoming the pore walls of the inner pore surface. The pore surface often presents a lenzitoid appearance. The diameter of the pores is small about 0.20 mm. No spores were found within the pores. (Singapore Field No. 5143).

T. F. CHIPP.

Paddy in the Economic Gardens.

Two adjacent fields measuring together 4398 square feet, or say, one tenth of an acre were put under Paddy on the 20th July.

The land selected is almost an ideal one for the purpose, being a flat of light sandy loam overlying a clay subsoil, which, owing to the low configuration of the ground, drains itself very slowly. After grubbing up the roots, which were heaped and burnt, the land was thoroughly broken up and strewn with the ashes. A corner of the field, 12 feet by 12 (= 144 sq. feet)* was, after 3

* Note—In Cochin China the rule generally followed is to allow, for the nursery 2 hundredths of the acreage to be planted,

hoeings, reserved for a nursery, with a small ridge on all four sides to retain the water which was poured over it from a water-hole near-by. One coolie was then put to tread the earth to a soft mud consistency, which was then levelled and smoothed. A quantity of 4 ounces of paddy, water-tested, which is equivalent to 75 pounds for one acre, was sown on the surface.

The paddy, so-called "hill paddy," used for seed, was unfortunately a very mixed lot containing many different varieties from the purple red "pulut rice" to various shades of brown and yellow, with black awns, or yellow awns, or no awns at all. One variety showed two well defined longitudinal brown stripes on a yellow husk. Some showed later a tall habit of growth with drooping ears, others grew shorter stems with ears almost erect.

As, however, there was no time to ascertain by selection the respective qualities of each individual variety, the seed was sown as it was received.

Transplanting began in the middle of August, when the seedlings were about 12 inches high. This was done after the nursery had been thoroughly watered, so that, the soil being wet and loose, the seedlings could be taken up with a ball of earth round their roots. The planting was done by women on lines one foot apart with ten inches' space on the lines, more or less regularly. Instructions were given to plant only one seedling per hole, and this, was adhered to as much as possible.

So far, the method applied had been that usually followed by natives in planting wet rice, under irrigation, except that the planting of wet rice is done when the fields are already under water, which was not the case here.

From the time of transplanting, the young plants were left to shift for themselves under the ordinary conditions which obtain for "hill" or "dry paddy," that is to say they received only the water from rains and no further labour was spent on them except a weeding before the flowering, and also that of scaring birds away, which was performed by a boy.

It may be here stated that the term "*dry paddy*" is open to misconception, for although hill paddy can be grown without irrigation, it, nevertheless, requires a considerable amount of rain at somewhat frequent intervals. Where such conditions do not prevail, where rains are not fairly dependable, the crop of so-called "*dry paddy*" has but poor prospects.

On the 10th December, about 4 months after transplanting, the cutting of the crop began at the ripest end of the field, the work henceforth was all done by Tamil women, who show quite a liking for it, and a marked expertness.

The harvesting was done by cutting the panicles with their stem down to the top leaf, the straw being left standing. Each woman having secured a handful of panicles tied it with the top leaf and laid the sheaf down to proceed further,

When the cutting was finished the sheaves were gathered and taken to a smooth piece of ground, where they were opened and exposed to the sun. At night the whole was taken up in mats and put under shelter.

Threshing began two days after by beating the ears with sticks, which causes the grain to drop to the ground. The small amount of broken straw which was on top was gathered by hand, leaving the paddy and chaff below. A first winnowing was done with the "neeru," a tray made of bamboo strips, to separate the grain from the finer pieces of broken straw, and a further winnowing was gone through to separate the light empty grains from the full grains, an operation requiring a great deftness of hand.

The crop taken off the 1/10 acre plot planted amounted to 16½ gantangs, which corresponds to a yield of 163 gantangs, weighing 937 lbs. per acre and is much below what might be expected from a trial made under such generally favourable conditions as described above.

But yet, from the first, the writer was under no illusion as to the possibilities of failure of this plot. It might give a satisfactory return—and it might not. An undrained swamp under a semi-aquatic vegetation of "Pandanus" and wild grasses, the land, until it was broken up, constituted an ideal breeding-ground for fungoid and insect pests, and it was a question whether after the thorough tillage (and thereby aëration) which it received, these pests would rally quick enough seriously to injure a crop new to it and a quick crop at that. Certain rotations, as it is well known, are devised on the immunity of certain crops to pests which attack other crops. If the paddy crop had matured, as some races do, in three months, it would have been a bumper crop but even at an early stage, when Mr. Richards, Entomologist to the F. M. S. Agricultural Department, saw it, the crop was already seriously attacked by a grub which he identified as "*Schoenobius bipunctifer*," a grub frequently found in stems of rice throughout India, and from that time, empty white ears were every day more and more conspicuous throughout the field. This borer belongs to the family of "Pyralidae" which, of all insect pests, is according to Lefroy's "*Indian Insect Life*" one of the most destructive to crops and stored products. The damage is done while in the larval state, it is hidden in the stem and its presence is only revealed when the ear of the paddy is actually dead, no grain being formed for want of the material which has gone to feed the grub.

Added to the toll taken by this pest, the depredations of birds seemed likely at one time to finish the crop. By dint of shouting and empty tin-beating, they were not allowed to have it all their own way, but many ears showed a heavy proportion of emptied husks. It is possible that the damage caused by birds is greater in small isolated spots surrounded, as was the case here, by trees and wild vegetation, where they find immediate shelter (to emerge

again a few minutes later) than on extensive paddy fields, where they have no shelter except by long flights. Be this as it may, they proved to be a most serious cause of loss in the present instance.

The above digression tends to emphasise one point, namely, the necessity of a clean field, especially in the case of so-called "dry" paddy. In the case of "wet" paddy, prolonged immersion under water tends to destroy or to check the breeding of noxious pests living in the ground; this is not the case with "dry" paddy which is only partially protected even by the most thorough cultivation. One may, it is true, come across very promising native paddy plots, raised without any cultivation to speak of, on virgin soil newly-cleared of its forest timber, but the case here is very different, for forest land is free from the pests which infest foul grassy plots where *Pyralidae* and *Noctuidae* breed freely.

Reverting to the crop taken from the paddy plot in the Economic Gardens, a test was made with 2 katties of the clean, threshed paddy, after five days' drying. It was made into "*Parboiled*" rice by first steeping the paddy some hours in water, then boiling it for 40 minutes when the husks began to crack, then drying it, and finally husking it with the ordinary mortar and pestle.

The result for 2 kattis (2 lbs., 10 ozs.) was:—

	lbs.	ozs.
Clean rice fit for the the table ..	1	12
Broken rice		1 $\frac{1}{4}$
Husk and small broken rice ..		9 $\frac{1}{4}$
Fine bran		$\frac{1}{2}$
	2	7

The balance being probably moisture.

The rice, raw, had a pleasant odour and, cooked, an agreeable flavour without the nauseating smell which generally accompanies parboiled rice bought from the shops; smell which is due, most probably, to the steeping of the paddy in water which is rendered foul by the repeated immersions which it is used for.

As already stated, the seed employed in this trial was very mixed and the crop obtained naturally reflected this heterogeneous character. Hence no conclusion can be drawn without further trials, after selection, as to the best variety among the different types harvested, the more so as their distinctive characters, the results possibly of crossings, may not be constant.

The writer is unaware whether investigations have been made in Malaya with a view to the improvement of the local races of rice. Mr. Pasqual's very able pamphlet "*Paddy planting in Malaya*" has just a few words on the subject. Yet, we read that the relative outturn of paddy per acre in Burma and Malaya is as 13 is to 8, other things being equal, by which is meant, we presume,

equal soil fertility, equal seasonal conditions, equal facilities of irrigation. Thus we may take it that, whereas the Malay wins 150 gantangs, (say), from one acre, the Burmese wins 243 gantangs i.e. 93 gantangs more, or just about enough to feed, under present conditions of shortage, two people for one year.

When we read this, we naturally seek an explanation in one of the two following reasons, or in both:—

No. 1 Faulty cultivation.

„ 2 Poor seed.

The writer lays no claim to expert knowledge in the cultivation of rice, having had but a passing acquaintance with it, until a few months ago. Having, moreover, never been to Burmah, he is unable to compare the two modes of cultivation of the Burmese and the Malays, the only comparison he is able to make is with the little he has seen of it in Java, and in Cochin china, and judging by these standards, he cannot but be of opinion that the Malay paddy planter is the less efficient of the two. Perhaps it is due to the scarcity of buffaloes that the land is less thoroughly puddled, less plowed and rolled: to the scarcity of Kampong population, that the preparation of the land is so scanty, the maintenance of its fertility so little thought of, the embankments so inefficiently made. During a recent trip of the writer through the Malay States, as late as last November, Malays could be seen in the Krian District, still preparing their land for the planting of the paddy crop—that is, if such work as he saw can pass as preparing the land. This consisted in cutting the stubble and rank grasses with the “Tajak” and piling it in straight lines, in squares, actually to form the banks. That stubble which should have gone back to the soil for the sustenance of the crop, was made simply to serve as pathways through the fields. Such treatment of the land not only tends to starve it, but it must also foul it, as these piled up grasses will surely, bye and bye, serve as harbours for rats and vermins, and then what of the crops?

Regarding the amelioration of the seed, that is a matter in which the individual planter can do but little. He may, and does, in countries where husbandry is highly developed, like Japan, obtain by rough methods of selection, a certain degree of uniformity in his crops, but the establishing of improved strains of a permanent character is a work of slow processes, which Governments alone are competent to carry through.

Such work is now being eagerly pursued in regard to wheat in all wheat-growing countries and, now, following the methods of pedigree cultures from single seeds initiated by the Slavof Station in Sweden, Japan, Java and India have also opened stations for the close study of the cultivation and improvement of rice. High yielding varieties have already been obtained and Buitenzorg was credited, a few years ago, with having raised on its trial fields a variety yielding 76 pickels of rice per bouw ($2\frac{1}{2}$ tons per acre).

On the Pollen of *Carica Papaya*.

The following notes on the flowers of the Papaya (*Carica papaya*) are compiled from the observations of some plants grown in the Economic Gardens, Singapore.

An examination of the pollen of different types of flowers showed a considerable difference in the germination of the pollen grains but unfortunately, owing to thefts of fruit the ultimate results of the work could not be observed.

Pollen from four different types of flowers was examined.

1. Flowers with ten stamens from dioecious plants. 2. Flowers with ten stamens from plants bearing both male and hermaphrodite flowers. 3. Flowers with five stamens from hermaphrodite plants. 4. Flowers with ten stamens from hermaphrodite plants. Flowers with the number of stamens varying between five and ten were omitted.

In all cases the pollen grains appeared to be identical. When dry the germ spore is not visible but when the grain has been soaked in water it swells up, becomes turgid, and the germ spore can be distinctly seen.

To ascertain if there was any difference in the time taken for the pollen from the four different types of flowers to germinate, pollen grains were cultivated in a sucrose gelatine medium in a hanging drop culture.

In the first experiment pollen from the first and second types of flowers mentioned above behaved practically the same, all the grains germinating and growing well. Similarly the pollen from the third and fourth types of flowers behaved almost identically but they both germinated several hours later than those of the first two types.

A second experiment was conducted using pollen from the first two types of flowers only, when it was found that pollen of the first type germinated half an hour before that of the second type.

The deductions to be drawn from these records so far as they effect pollination are not at present quite evident, and require further observations to be carried out.

G. B. DESHMUKH.

Some Trials of Food-plants in the Economic Gardens, Singapore.

Ragi ("*Eleusine Coracana*")

In the *Singapore Free Press* of 23rd October, will be found a short account of this plot, of the method of cultivation followed, and an estimate of the yield of seed expected.

Briefly, this plot of 3980 square feet or say, one eleventh part of one acre, was stocked with 2675 seedlings transplanted on the 20th July from a nursery sown on the 29th June. The plot was divided into 18 beds, and the planting was all done on these raised beds at 12 by 12 inches.

An estimate made on October 5th put the expected crop at 20,000 panicles yielding 177 lbs. of clean dry seed.

The last gathering has now taken place and the result of the crop is shown by the following figures:

Dates of picking.	Number of panicles.	lbs.	ozs.
28th September	218	2	—
1st October	360	3	15
6th „	880	7	11
9th „	1030	8	8
12th „	not counted	4	2½
16th „	430	2	—
20th „	970	10	8½
26th „	4000	48	—
3rd November	10000	80	—
10th „	7000	17	—
Totals	24888	183	13

Thus the crop of one eleventh of one acre totalled 183 lbs. 13 ozs. of clean dry ragi ready for grinding, equivalent to 2000 lbs. or 300 gantangs per acre.

It is probable judging from the number of panicles collected, which is far in excess of the estimate previously made, that the crop would have been greater but for the depredations caused by birds. Although a boy was employed lustily beating a kerosine tin, it is feared that the toll taken on Sundays and holidays was somewhat considerable, as is shown by the short weight of the last picking of 10th November, which for 7000 panicles only gave 17 lbs. of clean seed—a great number of panicles being found empty of seed. The crop was sold at 7 cents per lb. realising \$12.80 which is equivalent to a gross return of \$140.80 per acre.

From the date of sowing the seed in the nursery on 29th June, to the last picking, the crop had occupied the ground for 4 months and 12 days.

The piece of land on which this trial was made is very low, rather wet and liable to floods, with a loose friable and deep soil, quite suitable to the cultivation of ragi if it could be properly drained. Fortunately no flood occurred to spoil the crop, and the weather was moreover propitious throughout, except just towards the end when excessive rains may possibly have delayed the ripening of the grain, affecting thereby the colour of the seed which lacked the brilliant orange tint of the previous lots.

Except the changkoling of the land and the making and raking of beds, the work, from the transplanting of the seedlings to the harvesting of the crop and the de-husking of the grains, was almost wholly performed by women, who seem to take to this work with the zest which attaches to the familiar tasks of farm life.

The gathered crop was treated in the following way. The panicles, cut close to the base of the spikelets, were brought in in baskets and put in heaps of ten, then in heaps of 100 to get an exact count of the crop. The whole day's gathering was then exposed to the sun on a concrete floor and after a few hours drying, the whole was trodden under with the feet, the right foot being now and again used in a twisting motion to tear the spikelets asunder. The result was a mixture of husks, of nerves of panicles, and of grain which was then taken up on trays, the ordinary "neerus" of the country—and there, after three circular motions and a final jerk upward, the seed, absolutely clean, was dropped in a basket in front, the remaining waste being thrown aside. This work requires great deftness of hand and tamil women excel at it.

E. MATHIEU.

(To be continued.)

Coconut Bud Rot.

The Philippine Journal of Science Vol: XIV, No. 1, January, 1919 contains a valuable addition to our knowledge of the disease known as "bud rot" which causes such severe losses of coconut trees throughout the tropics. Mr. Otto A. Reinking after giving a short history of the symptoms of the disease gives in detail his investigations both in the laboratory and the field. In his conclusions he states that the actual cause of the disease is a fungus *Phytophthora Faberi* Maubl. which in the majority of cases is quickly followed by bacteria which rapidly destroy the weakened tissues, causing the familiar rot.

As the fungus is the same that attacks coconut seedlings, cacao fruit, Hevea rubber seedlings, and papaya fruit, and as it is impossible to cure trees badly infected he gives the following instructions:—

1. Systematic inspection, condemning and burning of all diseased coconut trees.
2. All parts of diseased trees must be burned, otherwise the organism will live as a saprophyte on dead matter, and then spread to healthy trees.
3. Clean cultivation ought to be practised in all groves.
4. Under no circumstances should coconuts be interplanted with cacao or papayas.
5. If coconuts are planted near diseased Hevea rubber, precautions should be taken to avoid the spread of the disease.
6. Trees in new groves must be planted 10 meters apart each way. This spacing is one of the most satisfactory means of control against bud rot, and at the same time tends to give the highest production of nuts.

T. F. C.

• Reviews of Local Publications.

From a perusal of the recent publications of the Scientific departments of the surrounding countries one is struck with a noticeable change in the type of article now appearing. Hitherto one has had the preliminary records and interim reports of the pioneer who tackled any subject that from time to time assumed economical importance. Now one sees on all sides attempts to sum up the information so far gathered and published piecemeal and the result is a series of comprehensive papers, one might almost say monographs, which are now appearing and which deal exhaustively so far as our knowledge up to date goes of whole subjects rather than isolated and unconnected items. It would seem that the first period of preliminary investigation of the pioneer who was an all round scientific and technical man has closed and that in future the specialists who have been arriving in these parts in recent years will each conduct his investigations henceforth in a much more restricted field but correspondingly probing into his subject all the more deeply.

In illustration of these comprehensive articles referred to the following are representative.

Plantes et produits filamenteux et textiles de l'Indochine. Crevost et Lemasie. Bulletin Economique de l'Indochine, 1919, No. 138. A brief description is given of each plant and the manner in which the fibre is obtained. The plants are arranged according to their Natural Orders. The article is illustrated by fifteen wood cuts which greatly facilitate the determination of the plants, and five photographs shewing plantations and the preparation of fibres.

Studies of Philippine Bananas. E. Q. y Arguelles. The Philippine Agricultural Review Vol. XII, No. 3. This is a comprehensive study of the varieties of bananas in cultivation in the Philippines. It is estimated that the College of Agricultural has over 600 varieties under culture and about one third of them have been definitely identified. A key is given which enables these varieties to be recognised, and is followed by descriptions of varieties of *Musa sapientum*. Thirty four plates are given at the conclusion of the article which enables one readily to distinguish the differences between the different kinds of flowers and fruits.

A biological and systematic study of Philippine Plant Galls. L. B. Uichanco. The Philippine Journal of Science Vol. XIV No. 5. This subject has been treated in a series of articles on Javanese, Sumatran and Celebes galls by W. and J. Docters Van Leenwen-Reijman van Buitenzorg, but the present article on the Philippine galls is in English and therefore much more accessible to residents of Malay.

The galls and their causative insect agents are described in detail and the fifteen plates accompanying the article greatly assist in their identification.

Bamboos. To anyone interested in bamboos the handbook on this subject by Brown and Fischer issued as Bulletin No. 15 of the Philippine Bureau of Forestry is a most useful work. A key is given by which the species can be determined in the field from general observation and without entering into minute detail. General descriptions of the species are given, cultural notes and the results of observations of the plant grown in plantations. Thirty-three photographic plates shewing the characteristics of the species individually and in plantations increases the value of the work.

Philippine Mangrove Swamps. W. H. Brown and A. F. Fischer. Bulletin No. 7 of the Bureau of Forestry of the Philippines is devoted to an account of Mangrove swamps. A list of species to be found in the swamps is given and a special key based on superficial characters which enables one to ascertain the name of anything down to a fern. Although primarily a study in the Philippines, Malay native names are included which greatly enhances its value to us in Malaya. A general description is given of each species and the cultivation of mangrove forests and their estimated yield of timber is recorded. Its economical uses are considered both as a firewood and as a tanbark and dye. A chapter is devoted to the uses and cultivation of the Nipa Palm. The whole booklet is lavishly illustrated by photographs and forms a valuable addition to the handbooks of special ecological formations of this part of the world.

Fruit Culture in Malaya. J. N. Milsum. The F. M. S. Department of Agriculture, Bulletin No. 29. This book bringing together our knowledge of local fruit trees and their cultivation has long been needed, and the want is supplied in the present publication. The author begins with a discussion of the past and present position of fruit cultivation and then suggests lines on which local fruits can be improved. General methods of cultivation are given and discussion on soil and diseases.

The article concludes with descriptions of fruit trees according to their general utility, and suitable localities. Twenty-three excellent photographs of fruits and trees are included in the work.

Food Production in Malaya. F. G. Spring and J. N. Milsum. F. M. S. Department of Agriculture Bulletin No. 30. This is a companion volume to the preceeding and treats of the cultivation of food crops in general from all points of view.

T. F. C.

RAINFALL at the Director's house, Botanic Gardens, Singapore
during the first half of the year 1919, in inches.

Readings taken always at 8 a. m. and credited to the
date in which the twenty-four hours begin.

Date.	Jan.	Feb.	March.	April.	May.	June.
1	trace.	.12	nil.	nil.	.04	.52
2	.09	nil.	.09	.14	nil.	.44
3	3.99	nil.	1.42	.60	.23	.99
4	.06	trace.	1.04	.06	trace.	.24
5	.17	nil.	.22	.23	nil.	.02
6	.29	nil.	trace	nil.	nil.	.02
7	.09	.13	trace	nil.	.35	trace.
8	.18	1.04	2.08	.18	.44	.49
9	.05	.07	.09	.06	1.68	.01
10	.09	nil.	.40	.29	trace.	nil.
11	2.06	nil.	.02	1.15	.32	.02
12	1.46	nil.	trace.	1.03	.01	nil.
13	.29	.21	nil.	nil.	.01	.81
14	nil.	nil.	nil.	nil.	nil.	.01
15	nil.	.72	.02	.03	.02	.01
16	nil.	.27	.26	.02	nil.	nil.
17	.01	nil.	nil.	.02	.01	trace.
18	.19	nil.	nil.	.12	.52	nil.
19	.03	.16	nil.	.55	1.09	nil.
20	1.21	.33	trace	.03	.03	trace.
21	.10	nil.	.20	.17	nil.	nil.
22	.01	.63	.02	.77	.15	nil.
23	.36	.59	trace.	.04	.50	trace.
24	.41	.02	.96	nil.	.15	.16
25	trace.	nil.	.26	nil.	1.24	nil.
26	1.16	.34	.04	1.47	.03	trace.
27	.74	.03	trace.	.33	.01	.54
28	.78	.08	1.26	nil.	1.13	.04
29	trace.	...	.96	trace.	.48	trace.
30	.67	...	nil.	.03	.02	.01
31	.83	...	.58	...	nil.	...
	15.32	4.74	9.92	7.32	8.47	4.33

RAINFALL at the Director's house, Botanic Gardens Singapore
 during the second half of the year 1919, in inches,
 Readings taken always at 8 a.m. and credited to the
 date in which the twenty-four hours begin.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.01	2.01	trace.	.02	.40	.01
2	nil.	.50	.13	.45	trace.	.26
3	nil.	.01	nil.	.35	.65	.29
4	nil.	nil.	.43	.45	.27	.03
5	.04	nil.	trace.	.60	.14	nil.
6	trace.	nil.	nil.	.20	trace.	nil.
7	.02	nil.	nil.	1.00	.10	1.20
8	.12	.04	nil.	.36	1.35	.67
9	2.20	nil.	nil.	1.35	.24	.26
10	.01	trace.	nil.	.11	trace.	nil.
11	.02	.36	.18	1.67	.25	.86
12	.01	trace.	.02	trace.	nil.	.28
13	.02	.05	trace.	nil.	.95	.19
14	.42	nil.	trace.	nil.	trace.	trace.
15	.02	nil.	.03	nil.	.47	.19
16	.01	2.38	nil.	nil.	trace.	.02
17	trace.	nil.	nil.	trace.	trace.	nil.
18	.15	trace.	nil.	nil.	.06	trace.
19	.38	.03	nil.	1.40	nil.	.30
20	.21	nil.	trace.	.01	.18	.33
21	2.05	.06	.05	.01	.77	trace.
22	.15	nil.	.86	.07	.06	1.63
23	2.07	.90	trace.	trace.	trace.	1.25
24	.21	nil.	.02	nil.	.05	.39
25	nil.	nil.	2.70	.20	.02	.15
26	nil.	nil.	.15	nil.	.43	.02
27	nil.	.08	nil.	.85	.01	.01
28	nil.	.05	.07	.04	nil.	.08
29	nil.	nil.	.09	trace.	.73	.18
30	nil.	nil.	.09	trace.	.62	.02
31	nil.	.15	...	1.80	.01	.13
	8.12	6.62	4.82	10.94	7.76	8.75

RAINFALL at the head of the Waterfall Gardens, Penang during the first half of the year 1919, in inches.

Reading taken at 8 a.m. and credited to the date in which the twenty-four hours begin. Data kindly supplied by the Municipal Commissioners of George Town, Penang.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	...	...	...	...	.25	...
2	...	...	...	.95	...	...
3	...	...	...	...	.42	1.30
4	.08	...	...	.66	1.85	.12
5	...	...	...	...	.19	...
6	.20	...	...	.85	...	...
7	.86	...	...	.25	...	...
8	.03	...	.09	.05	.05	...
9	...	...	.13	...	.30	...
10	.04	.53	...	...	1.84	...
11	...	...	...	.30	.03	...
12	...	...	...	1.75	.34	...
13	.24	...	...	...	...	.18
14	...	...	1.28	...	.26	...
15	...	.14	..	.03	.22	...
16	...	...	.06	.07	.03	...
17	...	...	...	.61	.25	..
18	...	1.16	...	.03	..	...
19	.25	...	...	.17	...	...
20	.55	...	...	.32	.19	.33
21	...	...	...	.03	.17	.18
22	...	1.85	.31	...	...	...
23	...	...	.07	1.85	.62	...
24	.07	..	1.13	.55	.08	...
25	...	...	...	.03	...	...
26	.42	...	.83	...	.61	.37
27	...	...	.05	...	.88	1.20
28	.22	...	.03	.05	1.95	.27
29	...	...	1.77	...	.83	.12
30	...	...	.05	...	.09	...
31	...	...	1.05	1.78	...	...
	2.96	3.68	6.85	10.33	11.45	4.07

RAINFALL at the head of the Waterfall Gardens, Penang during the second half of the year 1919, in inches.

Reading taken at 8 a.m. and credited to the date in which the twenty-four hours begin. Data kindly supplied by the Municipal Commissioners of George Town, Penang.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	...	...	...	.88	.04	.03
2	.08	.50	.10	1.10	.22	.30
3	...	.42	...	1.05	.05	.15
4	...	...	...	...	...	...
5	.24	.77	.34	1.76	.24	.20
6	...	.23	.05	.63	...	.34
7	.85	.43	.09	.64	.63	...
8	.09	.06	...	1.88	.63	.24
9	...	.20	...	.80	.58	...
10	1.23	...	.85	.53	.17	...
11	.78	...	.31	1.53	.03	.10
12	...	...	1.15	.20	.29	...
13	.07	...	.54	.07	.03	...
14	...	.32	3.12	...	...	...
15	.12	.20	.10	.80	.79	1.33
16	.05	.56	.75	...	.03	.56
17	.55	...	...	...	...	.13
18	...	...	...	...	.30	...
19	...	...	.58	...	.12	.03
20	.03	.03	1.58	...	1.45	.56
21	.32	...	.03	...	.03	.15
22	.74	...	.15	...	.48	.07
23	...	...	.60	.24	...	...
24	.67	.29	.20	...	.53	...
25	.44	.10	.07	.17	.14	.12
26	...	.03	.32	.23	.03	1.69
27	...	.18	.14	.09	.07	...
28	...	.06	.03	1.07	.12	.57
29	...	.03	...	.35	1.15	.45
30	...	...	...	...	...	...
31	...	...	...	...	...	...
	6.26	4.41	11.10	14.02	8.15	7.02

SUMMARY OF RAINFALL FOR 1919.

	SINGAPORE.		PENANG.	
	No. of rainy days.	Longest spell without rain.	No. of rainy days.	Longest spell without rain.
January - - -	25	3	11	5
February - - -	15	3	4	9
March - - -	18	3	13	7
April - - -	21	2	19	2
May - - -	22	2	22	2
June - - -	16	2	9	8
July - - -	19	7	15	6
August - - -	18	4	17	4
September - - -	13	5	21	2
October - - -	19	4	19	7
November - - -	21	1	24	1
December - - -	24	2	18	3
Greatest amount in 24 hours ...			3.12	in.
„ „ 48 „ ..	4.08 in.		3.66	in.
„ „ 72 „ ...	4.27 in.		4.81	in.

